

## **APPENDIX C**

### **ITS SYSTEM ARCHITECTURE AND STANDARDS**

This appendix provides definition of a “system architecture,” and presents an overview of the transit involvement in the ongoing national ITS system architecture program.

## **Objectives of a System Architecture**

A system architecture is simply a description of how system components interact to achieve system goals. It accomplishes three main objectives:

- Defines complete system operation;
- Defines what each component does; and
- Defines what information is passed between components.

For simple systems an architecture may provide little benefit, but for a large complex system a system architecture is tremendously helpful. Meeting the first objective assures that everyone agrees on the finished system operation and that no major functions are overlooked. The second objective is the embodiment of the “divide-and-conquer” methodology, with the added twist of looking for opportunities for shared use of components. The third objective is a definition of which components need to communicate and what information is passed between components, which is necessary to allow independent development of the components. Overall, a system architecture organizes and guides system development in the same way that Gantt and PERT charts aid project management.

A system architecture, however, is *not* a system design. It does *not* specify how each component accomplishes its task or a component’s look-and-feel. It is an *organization of functions*, not a specification of equipment. Nevertheless, it does have a strong influence on the design. For example, the architecture facilitates the development of standards which can flow directly from the specification of communications pathways. The resulting standards ensure equipment compatibility and interoperability, resulting in larger, more stable equipment markets and the accompanying reduction in component costs. The architecture also minimizes system costs by assuring that the system is sensibly deployed with a minimum of redundant equipment.

To better understand the system architecture concept and its usefulness, consider the example of a home stereo system. Consider if the radio, compact disk and cassette recorder were considered independently rather than as a system. To provide the full function of the system, without a system

architecture, would require three amplifiers, three sets of speakers, and three volume controls. The speakers and amplifiers are especially troublesome because they are some of the most expensive components. In contrast, consider an integrated home stereo system architecture. The architecture reduces the system to a single amplifier and a single set of speakers, a tuner, a CD player, and a cassette tape deck, but adds the complication of “Sound Input & Output Controller.” Note that this component was not initially envisioned, but an analysis of the complete system suggested the need for it. Similarly, by splitting the amplifier into two stages the headphone/speaker output selector could be integrated into the “Sound Input & Output Controller,” with the pre-amplifier providing sufficient output to drive the headphones. Both the independent and the integrated architectures meet all the system goals, but the integrated one provides the sensible sharing of speakers and amplifier, which are some of the most costly elements.

The system architecture development can also go one step further and specify *a physical* architecture, which indicates which functions should be co-located. These decisions are based on issues like communications costs, functional needs, or other factors. For a typical home stereo system, the radio receiver, compact disk player, and cassette player are packaged separately to allow users to purchase only functions they desire. Everything else is packaged as a single component because these components are needed by all other components. The speakers are separate because they may be large and would be impractical to pack with the electronics components. More importantly, the customer may purchase his components from any manufacturer, confident they will work well together, thanks to the “architecture” of the home stereo system. If an architecture is so helpful to a simple home stereo system, it becomes absolutely essential for an extremely complex system such as the Intelligent Transportation System.

### **The National ITS System Architecture Development**

Central to the successful realization of a national Intelligent Transportation System is the establishment of a unifying national ITS architecture. If carefully designed, it will ensure that a nationally compatible system is developed, linking all modes of transportation. The architecture will promote national standards to accommodate intercity travel and cross-country goods movements, while discouraging local or regional areas from developing incompatible ITS implementations. The

national ITS architecture will “...allow stakeholders to adopt the elements of ITS in the manner and time frame of their choosing, enable these elements to be supplied by multiple vendors, serve as the foundation for standards that can reduce duplication of effort by stakeholders, speed the introduction of ITS products and services and reduce the risk for the private sector developing these products and services.”“““

Recognizing the ITS program’s need for a system architecture, the US DOT initiated the National ITS Architecture Development Program. The US DOT selected contractor teams to produce alternative architectures for a 20-year planning horizon (1992-2012). The program was divided into two phases. The first phase began in September 1993 with four teams, led by Hughes Aircraft, IBM-Loral, Rockwell International, and Westinghouse Electric, competing to produce the best architectures. Phase II began in February 1995 with two selected teams, Loral and Rockwell International, working together to merge and refine their architectures into a national standard. The architecture is scheduled to be completed by the end of February 1996 with a national review of the architecture scheduled for June 1996.

The foundation of the ITS system architecture is the set of 29 User Services. The services are listed in Table C. The user services address a broad spectrum of services including advanced vehicle systems, transportation management, and electronic payment services. The goal of the National ITS System Architecture Program is to unify and organize the user services and promote standards that assure seamless operation of the system from coast-to-coast.

The 29 ITS User Services have been grouped into seven “bundles” of services that are related in some way, either by the common users of those services (such as Commercial Vehicle Operations), or by the similarity in technologies and functions (such as Travel and Transportation Management). (See Table C.) Transit, or Public Transportation, is represented by the grouping labeled Public Transportation Operations.C-2

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**[C-1] ITS Architecture Development Program: Interim Status Report, ITS America, Washington, D.C., April 1994.**

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Table C ITS User Services	
<b>TRAVEL AND TRANSPORTATION MANAGEMENT</b> En-Route Driver Information Route Guidance Traveler Services Information Traffic Control Incident Management Emissions Testing and Mitigation	<b>COMMERCIAL VEHICLE OPERATIONS</b> Commercial Vehicle Electronic Clearance Automated Roadside Safety Inspection On-Board Safety Monitoring Commercial Vehicle Administrative Processes Hazardous Materials Incident Response Freight Mobility
<b>TRAVEL DEMAND MANAGEMENT</b> <b>Pre-Trip Travel Information</b> <b>Ride Matching and Reservation</b> Demand Management and Operations	<b>EMERGENCY MANAGEMENT</b> Emergency Notification and Personal Security Emergency Vehicle Management
<b>PUBLIC TRANSPORTATION OPERATIONS</b> <b>Public Transportation Management</b> <b>En-Route Transit Information</b> <b>Personalized Public Transit</b> <b>Public Travel Security</b>  <b>ELECTRONIC PAYMENT</b> <b>Electronic Payment Services</b>  (APTS-Related Services in Bold Type)	<b>ADVANCED VEHICLE CONTROL AND SAFETY SYSTEMS</b> Longitudinal Collision Avoidance Lateral Collision Avoidance Intersection Collision Avoidance Vision Enhancement for Crash Avoidance Safety Readiness Pre-Crash Restraint Deployment Automated Highway Systems

### Transit Involvement in the System Architecture Program

The Federal Transit Administration has tasked the Volpe National Transportation Systems Center and Sandia National Laboratories to assist the architecture development teams and to identify transit-specific requirements. A major product of this work was the development of a set of information flow charts. These flow charts present the logical information flows that satisfy the needs of the APTS user services. The flow charts, together with a narrative description, have been provided to the architecture teams as well as members of the transit community.

In addition to the development of the transit architecture requirements, the Volpe Center and Sandia National Laboratories have conducted outreach activities to inform the transit community of the national architecture development program and its benefits to the industry.<sup>03</sup>

## **Standards Development**

As indicated above, a national architecture facilitates the development of necessary ITS and APTS standards. One of the first ITS standards was an APTS standard, namely the standard for bus vehicle area networks, SAE J1708. This standard was developed through the efforts of the ITS America's APTS Committee/Bus Vehicle Area Network Working Group.

On the international front, the International Standards Organization has established Technical Committee (TC) 204 to develop standards for Transport Information and Control Systems. Due to U.S. leadership in both Intelligent Transportation Systems (ITS) technologies and development of internationally recognized ITS standards related to transit, the U.S. has been designated the International Secretariat of TC 204. The formal structure of TC 204 consists of 16 international Working Groups. Working Group 8 for Public Transport and Emergency Services is one of these groups.

The U.S., in support of these international Working Groups, has set up a parallel U.S. committee structure to provide the technical expertise which can be used to provide U.S. input to the Technical Committee 204 Working Groups. Therefore, a U.S. Working Advisory Group (WAG) 8 is being developed to **support** TC 204 Working Group 8. The WAG 8 Administrator is the Volpe Center; WAG 8 membership is being assembled from highly-qualified private industry and transportation agency sources. The WAG will serve as a source of experts for nomination to TC 204/Working Group 8.<sup>C4</sup>

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